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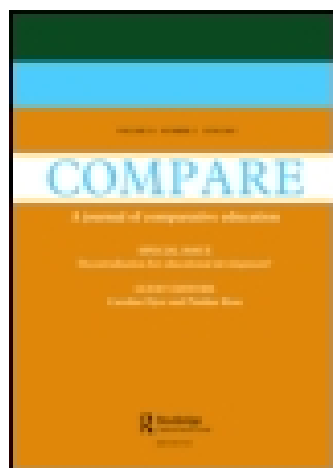
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The flow of international students from a macro perspective: a network analysis

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The flow of international students from a macro perspective: a network analysis

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This paper provides a network analysis of the international flow of students among 210 countries and the factors determining the structure of this flow. Among these factors, bilateral hyperlink connections between countries and the number of telephone minutes (communication variables) are the most important predictors of the flow's structure, followed by trade, the physical distance between countries, a common border between countries and a common language between two countries. The USA is by far the most central country in the flow of international students, followed by China, the UK, France, Germany, Australia and India. These results are discussed in light of World-System Theory. Future research should examine how the network of international student flows changes over time and consider additional factors to provide a better understanding of the network as an international system.

Keywords: flow of international students; network analysis; globalisation and international higher education; internationalisation of higher education; mobility of students

The international flow of students has become an increasingly important research topic because of the increased numbers of foreign students after WWII (Goodwin 1993), which was mainly derived from the impact of internationalisation and globalisation (Maringe, Foskett, and Woodfield 2013; see also Maringe and Foskett 2010). It is estimated that about three million tertiary students studied abroad in 2007 (OECD 2009), reflecting an increase from less than one million in 1980. Economically developed English-speaking countries such as the USA, the UK, Australia, Canada and New Zealand are core destinations of foreign students pursuing higher education abroad (OECD 2009; UNESCO 2008).

In capturing the structural features and patterns of student mobility across different countries, the concept of networks has recently gained wide

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acceptance (e.g., Chadee and Naidoo 2009; Chen and Barnett 2000; Jiang 2014). Contemporary network theories see social structure as consisting of a set of social relationships or links between different actors such as people, organisations, countries or events. Network theories assume that actors and their actions (or influences) are interdependent rather than independent (Wasserman and Faust 1994). Network analysis has been rapidly developed as a key tool for examining various structural concepts. In network analysis, the patterns of relationships and links are measured and visualised by relational metrics and graphs, respectively, which include virtually any network content such as flows of international students, flows of materials, power or advice.

Equipped with these theoretical and analytical perspectives, recent studies have identified that the network of international students has changed dramatically over the last few decades (e.g., the emergence of regional hubs), although the core countries noted above remain at the centre of the network (Chen and Barnett 2000). In addition, Asia is the single largest source of international students and has assumed a more central position in the network (Chadee and Naidoo 2009; Chen and Barnett 2000).

Recent studies of the flow of international students have mainly focused on the factors pulling and pushing students to seek higher education abroad (Mazzarol and Soutar 2001). At the macro level (including both countries and regions), scholars have examined public rationales that attract or compel international students to study abroad. They have suggested that positive developments in host countries, including educational policies to recruit more international students – for example, positive wage differentials, job opportunities, the emergence of organisations facilitating migration and favourable immigration policies – pull international students to seek higher education abroad (Brzozowski 2007; Massey et al. 1993; OECD 2013; UNESCO Institute for Statistics 2012; Wolfeil 2009; Woodfield 2010), whereas negative public developments in one's home country – including economic recessions, low living standards, a lack of economic opportunities and limited access to domestic higher education – push international students to go abroad for their studies (Altbach, Kelly, and Lulat 1985; Massey et al. 1993). In contrast, while increasing domestic higher education opportunities can attract international students to stay in their home countries, other factors can push them away from seeking higher education in a given foreign country (Li and Bray 2007). For example, unwelcoming attitudes toward international students after the 9/11 terrorist attacks in the USA are recognised as an important factor pushing international students away from there (Lee and Rice 2007). Visa problems (CGS 2004) are also regarded as a main cause of decreases in the enrolment of international graduate students in the USA.¹ Further, Kondakci (2011) argues that geographical proximity in itself is not a prime driver of student mobility unless other public rationales, such as linguistic proximity, are also embedded.

At the macro level, scholars have also investigated the flow of international students from the perspective of World-System Theory (e.g., Barnett and Wu 1995).² Limited by academic capability and a lack of sufficient technical skills, peripheral countries encourage students to pursue higher education in core countries with desired resources and knowledge to increase the level of education and thus facilitate nation building (Altbach 2003; Chen and Barnett 2000; Knight 2004; Marginson 2006). However, international students from peripheral countries who choose to stay in their host countries after graduation can be an important cause of the so-called 'brain-drain' phenomenon, which leads to the loss of human capital in home countries (Aupetit 2006; Kim, Bankart, and Isdell 2011).³ International students also benefit host countries that are at the centre of the world system in a number of ways (Heikinheimo and Shute 1986; IIE 2007; Klomegah 2006; Olivas and Li 2006; Zhai 2002). For example, international students can not only make substantial contributions to the US economy (IIE 2007) but also bring ethnic and cultural diversity to American campuses (Aslanbeigui and Montecinos 1998; Klomegah 2006; Lee and Rice 2007; Olivas and Li 2006). From this perspective, the pattern of international student flows from the periphery towards the core can, to a certain extent, reinforce the inequitable distribution of resources and knowledge (Chen and Barnett 2000; Lee 2008; Weiler 1984).

At the country level, other scholars have treated the country of origin as a predictor of the flow of international students and have suggested variables that have differential effects on international students' decisions to stay or return (Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011). For example, domestic access to higher education is an important factor influencing the flow of international students from China, India, South Korea and Thailand; tuition fees are important for students from Hong Kong, South Korea and Singapore; and global awareness is important for Chinese students (Chadee and Naidoo 2009). Examining stay/return rates for international students in the USA, scholars have found that Chinese and Indian doctoral students are most likely to stay in the USA upon completing their doctoral programme (Finn 1997) and that return rates for Taiwanese and South Korean students have started to increase because of rapid industrialisation and economic growth experienced by these countries in the 1980s and 1990s (Altbach 1991).⁴

Many scholars have claimed that the critical factors influencing the flow of international students are located mainly at the country level (e.g., Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011), whereas other scholars have argued that for a deeper understanding of this research topic, closer attention should be paid to activities of local agencies and agents such as higher education institutions/programmes, faculty members and students, instead of focusing only on the importance of country effects (e.g., Marginson and Rhoades 2002).

However, few studies have considered the flow of international students at the meso (i.e., institutional or community levels) and micro levels (i.e., individual or private levels). According to Lee (2008), the Internet is one of the most common information sources for international students, and among the possible factors attracting international students, the institution's national ranking and prestige are the most important, followed by assistantship, financial assistance and special education opportunities (Barnett et al. 2014). Kondakci (2011) finds that pre-departure pulling rationales at the private level are more prominent than public rationales for developing countries. Private factors include students' academic preferences, climate and food preferences, attitudes toward host countries and their people, language skills and choice of urban or rural locations. He also claims that after arriving in host countries, international students' academic, cultural and social experiences and the quality of student services in host countries play more significant roles in influencing the mobility of international students.

In addition, cultural, political and historical proximity between home and host countries are known to be important factors of the size and direction of student inflows in developing countries (Kondakci 2011; UNESCO Bangkok 2013). For example, because of the mass-migration history from the Balkans to Turkey, students from the Balkans share common historical, linguistic and cultural backgrounds with people in Turkey and, thus, are more likely to study in Turkey and feel comfortable with their cultural, social and academic experiences (Kondakci 2011). For somewhat similar reasons, Hong Kong has been regarded as one of the most popular destinations for mainland Chinese students for their higher education since the 1997 handover of Hong Kong from the UK (Li and Bray 2007; UNESCO Bangkok 2013). By contrast, cultural and language differences can hinder international students' social relationships with people in host countries and thus produce negative cultural and social experiences that push them away (Grey 2002; Pritchard and Skinner 2002).

From this perspective, it is not difficult to find the existence of regional hubs in the international flow of students.⁵ Kondakci (2011) suggests that in the periphery of the world system are regional hubs attracting students from other regions of the periphery. For example, Turkey is a regional hub that attracts students from the Balkans, the Middle East, Caucasia and Central Asia. Similarly, Mexico has been found to be a regional hub attracting students in other Latin American countries (Cantwell, Luca, and Lee 2009). In a similar vein, Hong Kong and Singapore have attracted students from neighbouring Asian countries (Chan and Ng 2008; Li and Bray 2007). In addition, from a global perspective based on the rapid development and increasing importance of regional trading blocs and reciprocal activities between higher-education systems of countries across such blocs, it is imperative to examine the stratified clusters in the structure of international student mobility at the regional level (Marginson and Rhoades 2002).

The factors predicting the flow of international students at the macro and micro levels described above are not mutually exclusive (Kondakci 2011) because there is a link between individuals and their society (Metcalf and Fenwick 2009). However, although public factors focusing on various aspects of life in host/home countries are thought to be a significant motivator of students interested in seeking higher education abroad (Kondakci 2011; Mazzarol and Soutar 2001; OECD 2013; Rivzi 2005; Teichler 2004), very little attention has been paid to the effects of student activities on their countries and higher-education policies of other countries. For example, (in)formal learning activities as well as socio-educational class experiences can be mediated in various contexts (e.g., the use of academic services and tools including search engines, class portals and social media) (Biddix, Chung, and Park 2011, 2015; Fadul 2014). In addition, at the global level, although scholars have argued that the mobility of international students is related to the world economy, politics and cultures (Cummings 1993; McMahon 1992; Slaughter and Leslie 1997; Sutton 1993), they have focused mainly on the effects of the global economy, politics and culture on the flow of students. For example, Sutton (1993) points out that the mobility of international students is sensitive to changes in the world economy, and Slaughter and Leslie (1997) claim that the global economy contributes to the commodification of students, faculty members and knowledge-based goods. However, very little is known about the extent to which the flow structure of international students impacts the pattern of the world economy, politics and culture. In particular, very few studies have examined the effect of the student flow on global systems in the context of an information society (Barnett and Wu 1995).

This paper presents a network analysis that examines the flow of international students at the global level and ascertains the antecedents of the mobility structure of international students at the macro level by considering the physical distance between capitals, common borders between countries and common languages shared by countries. This paper contributes to the literature on the flow network of international students at the country level by analysing countries' overall Internet hyperlink connections, telecommunications and trade relations and investigating the relationships between the flow network of international students, world trade and global hyperlink connections.

Methods

Data

Five different sources were utilised for data collection. First, the data on the number of international students at the tertiary level are obtained from UNESCO (<http://stats.uis.unesco.org/unesco>) for the latest available year

(usually 2011) for all of the 210 listed countries and territories. Second, the data on physical distance between countries were extracted from Google Maps. They were operationalised as the location of the country's capital, whose latitude and longitude were obtained from Google Maps. The location-to-distance conversion was performed using an R package called 'fields' (available at <http://cran.r-project.org/web/packages/fields/index.html>). This process was completed using a function that automatically takes a vector of longitude/latitude coordinates and calculates the great-circle distance between all points on the list of coordinates. The calculation is done using the spherical law of cosines to convert the distance into an arc measure based on the assumption of a spherical Earth with a radius of 6378.388 km. Third, the data on hyperlinks between countries specified by their top-level domains (TLDs) were extracted from data in Barnett and Park (2014). For the USA, three TLDs reserved for exclusive use by US institutions (.edu, .gov and .mil) are combined with .us. The hyperlink data were collected during November 2010, using Yahoo. This network indicates the extent to which potential students are able to access information on educational institutions in different countries. Fourth, to operationalise the ability to communicate with host universities in different countries, the data on the number of telephone minutes between countries for 2011 were obtained from TeleGeography (<http://www.telegeography.com/>) for 188 countries. These data were previously reported in Barnett et al. (2013). Finally, the amount of trade between countries was obtained from the United Nations Trade Statistics Database (<http://comtrade.un.org/db>).

Measures and analysis procedures

Three analytically complementary approaches were used: network analysis (including cluster analysis), quadratic correlation analysis and regression analysis.

First, for the network analysis, UCINET6.23 was employed to determine the density and centrality of the network and its clusters (hierarchical analysis) (Borgatti, Everett, and Freeman 2002). The network was drawn using its companion program NetDraw (Borgatti 2002), which uses a spring-embedded algorithm with node repulsion and equal-edge-length bias.

Notably, six network measures (i.e., density, in-degree centrality, out-degree centrality, share, betweenness centrality and eigenvector centrality) were used to describe the structure of the flow network of international students and the position of each country:

- Network density is the number of actual links in a network divided by the number of possible links ($n(n - \frac{1}{2})$).
- In-degree centrality refers to the number of inward links or total inward-link strength (the number of students).

- Out-degree centrality is the number of links directed outward or total outward-link strength. In this case, it is the number of students coming from a country.
- Share is the proportion of all links (or link strength) attributable to a node.
- Betweenness centrality measures the extent to which a node lies along the shortest path connecting all other nodes in the network (Freeman 1979) and is the proportion of all paths linking nodes j and k passing through node i . The betweenness of node i equals the sum of all b_{jk} . Therefore, betweenness centrality is a measure of the number of times a node occurs on a geodesic path (Borgatti, Everett, and Freeman 2002).
- Eigenvector centrality is an indicator of a node's overall centrality in a network (Bonacich 1972). The measure is calculated using weights for the first eigenvector and considers the positions of a node's links such that the node is more central if it is linked to more central nodes.

Second, to explore the relationship between the flow network of international students and other networks (e.g., communication network measured by telephone minutes between countries), the quadratic assessment procedure (QAP) correlation was used (Dekker, Krackhardt, and Snijders 2007; Krackhardt 1987).⁶

Third, based on the identification of associations between seven key factors (i.e., student flows, common border, physical distance, languages, communication, hyperlinks and trade) through QAP correlation analysis, their relationships were further modelled through QAP regression methods (Dekker, Krackhardt, and Snijders 2007; Krackhardt 1987) in order to predict the flow of international students through other factors, namely, common border, physical distance, languages, communication, hyperlinks and trade.⁷

It should be noted that the QAP methods have two key advantages over traditional correlation and regression methods. First, they directly test whether two matrices are similar to each other. QAP takes advantage of all dyadic information represented in each matrix and compares each dyadic cell in a network with the corresponding cell in another network. Therefore, it retains the dyad as the unit of analysis. Second, QAP makes no parametric assumptions. This is important because relationships in a network are not independent of one another.

Limitations

There are three limitations related to our data. First, certain countries provide no information on the number of international students studying in their countries. These include Argentina, Bangladesh, China, Egypt, Israel,

Singapore and the UAE. As a result of this systematic bias, the network described in this paper may be somewhat distorted, and therefore any interpretation of the results should be made with caution. Second, regarding hyperlink data, because .com, .org and .net are not exclusive to a specific country such as the USA, they are not included. This might underestimate the centrality of some countries that rely heavily on these top-level domains (Barnett, Chung, and Park 2011). At the same time, however, because this paper focuses on higher education and the USA is composed mainly of .edu websites, no serious issue is expected. Finally, given the limited accessibility to relevant data, we did not further tease out the network structures of student mobility in terms of types of degree, period and motivations.

Findings

The flow network of international students

Approximately 3.15 million students studied abroad in 2011, in 122 different countries. With over 650,000 international students, the USA is the most frequent destination, followed by the UK, Australia, France, Germany and Japan. China sends the most students abroad (almost 563,000), followed by India, Germany and South Korea. Table 1 shows the exact numbers.

The density of the flow network of international students is .1235. At least 12.35% of the countries are connected by at least one student as either from the home country or in the host country. When 100 students are required for a link between countries, network density drops to .0433 or 4.3%, indicating a relatively sparse network.

Table 1 shows the overall degree centrality, share, in-degree centrality, out-degree centrality, betweenness centrality and eigenvector centrality for all 210 countries. Overall, the USA is the most central country in the network, with an 11.4% share, followed by China (9.7%), the UK (6.7%), France (4.5%), Germany (4.3%), Australia (4.3%) and India (3.6%). In terms of betweenness centrality, the USA is by far the most central country, occupying a role as an information broker in the network. Its betweenness is more than double that of the next most central country, Canada. They are followed by the UK and Russia. Based on eigenvector centrality, the USA is the most central country, followed by the UK, Canada, France and Germany.

The results of the hierarchical cluster analysis reveal that the network is composed of four major clusters. The first group is centered about France, with Tunisia, Algeria and Morocco; the second, about Russia, with Belarus, Ukraine, Uzbekistan and Kazakhstan; and the third, about Germany, with Poland, Switzerland, the Netherlands, Bulgaria, Austria, Italy and Albania. The fourth group is the largest one and is composed of English-speaking countries (the USA, the UK, Canada, Australia, New Zealand and Ireland)

Table 1. Country centrality in international student flow network.

Country	Degree	Share (%)	Out-degree	In-degree	Between	Eigen
Afghanistan	5730	0.100	5730	0	0.000	9.156
Albania	21,552	0.400	21,186	481	0.003	8.869
Algeria	22,432	0.400	22,432	0	0.000	7.289
Andorra	1235	0.000	1235	25	0.000	1.664
Angola	13,755	0.200	7048	6707	0.060	6.745
Anguilla	120	0.000	120	0	0.000	1.000
Antigua Barbuda	373	0.000	268	136	0.060	1.228
Argentina	9380	0.200	9380	0	0.000	6.802
Armenia	7707	0.100	5741	3203	0.026	9.183
Aruba	423	0.000	382	41	0.003	1.078
Australia	251,338	4.300	10,302	250,610	1.314	20.772
Austria	70,498	1.200	12,727	68,468	0.341	19.686
Azerbaijan	13,272	0.200	10,922	5691	0.039	10.112
Bahamas	2705	0.000	2705	0	0.000	2.130
Bahrain	11,165	0.200	3546	8483	0.008	6.660
Bangladesh	20,746	0.400	20,746	0	0.000	9.487
Barbados	2503	0.000	1255	1629	0.208	2.329
Belarus	34,417	0.600	28,763	8481	0.115	13.371
Belgium	22,133	0.400	10,741	17,670	0.222	19.016
Belize	812	0.000	812	0	0.000	1.867
Benin	3528	0.100	3528	0	0.000	5.973
Bermuda	1256	0.000	1227	58	0.001	1.568
Bhutan	1208	0.000	1208	0	0.000	3.765
Bolivia	9565	0.200	9565	0	0.000	6.858
Bosnia Herzegovina	12,416	0.200	12,416	0	0.000	6.989
Botswana	8519	0.100	8519	0	0.000	4.533
Brazil	35,549	0.600	26,382	12,663	0.806	16.120
British Virgin Islands	571	0.000	376	225	0.016	1.492
Brunei	3293	0.100	3198	184	0.001	4.922
Bulgaria	31,318	0.500	23,865	9994	0.531	13.033
Burkina Faso	2902	0.000	2902	0	0.000	4.825
Burundi	3036	0.100	1243	1813	0.580	7.463
Cambodia	3021	0.100	3021	66	0.002	5.425
Cameroon	21,711	0.400	20,093	1758	0.050	9.816
Canada	118,083	2.000	45,078	86,454	3.417	22.548
Cape Verde	5158	0.100	5158	0	0.000	3.309
Cayman Islands	941	0.000	314	718	0.000	1.551
Central African Republic	83	0.000	0	83	0.000	0.527
Chad	3169	0.100	3169	40	0.979	4.386
Chile	10,066	0.200	8197	2161	0.074	8.287
China	562,859	9.700	562,859	0	0.000	13.557
Hong Kong	42,715	0.700	32,827	10,218	0.205	7.536

(Continued)

Table 1. *(Continued).*

Country	Degree	Share (%)	Out-degree	In-degree	Between	Eigen
Macao	15,053	0.300	1728	13,459	0.027	5.400
Colombia	22,305	0.400	22,305	0	0.000	8.597
Comoros	3082	0.100	3082	0	0.000	2.077
Congo	6111	0.100	6063	48	0.395	8.646
Cook Islands	209	0.000	209	0	0.000	0.587
Costa Rica	3079	0.100	2089	1424	0.029	6.978
Croatia	7418	0.100	6949	645	0.019	8.308
Cuba	30,229	0.500	1788	28,699	0.687	13.281
Cyprus	34,125	0.600	25,316	10,227	0.050	12.596
Czech Republic	39,863	0.700	11,941	34,596	0.179	18.332
D Republic of Congo	5501	0.100	5501	0	0.000	5.769
Denmark	13,607	0.200	3657	12,258	0.064	7.606
Djibouti	1621	0.000	1621	0	0.000	14.551
Dominica	756	0.000	756	0	0.000	2.815
Dominican Republic	3301	0.100	3301	0	0.000	2.374
North Korea	2050	0.000	2050	0	0.000	5.321
Ecuador	9823	0.200	9823	0	0.000	7.037
Egypt	11,596	0.200	11,596	0	0.000	9.640
El Salvador	3490	0.100	3086	713	0.042	5.515
Equatorial Guinea	1181	0.000	1181	0	0.000	2.996
Eritrea	935	0.000	882	53	0.001	5.487
Estonia	4047	0.100	3914	994	0.010	7.885
Ethiopia	5087	0.100	5087	0	0.000	9.165
Fiji	8723	0.200	1575	7242	0.149	3.189
Finland	18,089	0.300	7268	13,980	0.395	17.867
France	259,975	4.500	54,468	232,252	2.898	22.248
Gabon	1801	0.000	1563	394	0.062	4.956
Gambia	931	0.000	931	0	0.000	4.524
Georgia	9069	0.200	8652	802	0.043	9.233
Germany	251,893	4.300	103,212	182,306	2.878	21.916
Ghana	9928	0.200	7833	2538	0.504	11.044
Gibraltar	661	0.000	661	0	0.000	0.882
Greece	47,376	0.800	29,770	20,927	0.193	15.612
Grenada	4298	0.100	541	4119	0.421	4.268
Guatemala	2722	0.000	2722	0	0.000	6.448
Guinea	5459	0.100	5459	0	0.000	5.833
Guinea Bissau	2278	0.000	2278	0	0.000	3.548
Guyana	801	0.000	785	25	0.006	2.177
Haiti	3575	0.100	3575	0	0.000	3.495
Holy See	9196	0.200	7	9196	0.000	13.673
Honduras	3560	0.100	2905	790	0.023	5.763
Hungary	19,144	0.300	7989	14,441	0.212	14.619
Iceland	3001	0.100	2623	792	0.003	8.392

(Continued)

Table 1. (Continued).

Country	Degree	Share (%)	Out-degree	In-degree	Between	Eigen
India	209,773	3.600	200,971	11,762	1.604	17.763
Indonesia	37,059	0.600	34,089	6058	0.045	9.750
Iran	41,174	0.700	38,371	2944	0.100	12.645
Iraq	9635	0.200	9635	0	0.000	10.351
Ireland	26,989	0.500	19,625	11,716	0.121	16.541
Israel	13,555	0.200	13,555	0	0.000	9.916
Italy	98,423	1.700	43,832	61,008	0.763	20.877
Ivory Coast	6153	0.100	6153	0	0.000	5.832
Jamaica	2132	0.000	1865	581	0.560	3.683
Japan	174,289	3.000	40,476	141,617	1.685	20.298
Jordan	36,130	0.600	10,904	27,384	0.324	13.246
Kazakhstan	43,643	0.800	36,571	11,926	0.086	10.765
Kenya	13,313	0.200	13,313	0	0.000	10.237
Kiribati	1006	0.000	1006	0	0.000	1.371
Kuwait	13,875	0.200	12,323	2206	0.078	8.033
Kyrgyzstan	17,833	0.300	2712	16,275	0.023	9.437
Laos	4022	0.100	3836	715	0.079	4.526
Latvia	3893	0.100	3078	1705	0.023	10.249
Lebanon	12,124	0.200	12,124	0	0.000	10.351
Lesotho	186	0.000	186	0	0.000	2.796
Liberia	522	0.000	522	0	0.000	3.539
Libya	6983	0.100	6983	0	0.000	8.344
Liechtenstein	1135	0.000	953	569	0.000	1.814
Lithuania	10,702	0.200	8248	2896	0.044	10.376
Luxembourg	7500	0.100	6969	1227	0.003	8.024
Macedonia	6209	0.100	5137	1398	0.009	14.059
Madagascar	1846	0.000	689	1157	0.008	4.983
Malawi	2030	0.000	2030	0	0.000	5.119
Malaysia	105,952	1.800	53,860	56,189	0.846	17.968
Maldives	1864	0.000	1864	0	0.000	3.640
Mali	4206	0.100	3790	448	0.044	5.489
Malta	1191	0.000	1178	13	0.002	4.094
Marshall Islands	220	0.000	220	0	0.000	0.644
Mauritania	3502	0.100	3494	145	0.051	3.734
Mauritius	7620	0.100	7597	38	0.134	6.028
Mexico	26,066	0.400	26,066	850	0.017	8.526
Micronesia	0	0.000	0	0	0.000	0.000
Monaco	426	0.000	426	0	0.000	1.541
Mongolia	10,118	0.200	9776	969	0.026	8.619
Montenegro	4659	0.100	3886	805	0.039	5.433
Montserrat	52	0.000	52	0	0.000	0.915
Morocco	50,341	0.900	42,772	8086	2.693	14.214
Mozambique	2711	0.000	2711	0	0.000	6.249
Myanmar	6284	0.100	6266	50	0.000	5.576
Namibia	1752	0.000	529	1248	0.152	5.993

(Continued)

Table 1. *(Continued)*.

Country	Degree	Share (%)	Out-degree	In-degree	Between	Eigen
Nauru	132	0.000	132	0	0.000	0.526
Nepal	24,266	0.400	24,205	77	0.013	8.632
Netherlands	35,618	0.600	12,351	27,505	0.593	17.042
Netherlands Antilles	9	0.000	0	9	0.000	0.103
New Zealand	35,736	0.600	4662	35,721	0.243	14.887
Nicaragua	2502	0.000	2502	0	0.000	5.460
Niger	3221	0.100	2198	1105	0.065	5.353
Nigeria	39,000	0.700	39,000	0	0.000	11.971
Niue	72	0.000	72	0	0.000	0.664
Norway	22,109	0.400	12,947	13,004	0.400	18.420
Oman	5799	0.100	4866	1664	0.020	7.875
Pakistan	34,572	0.600	34,271	356	0.116	12.448
Palau	0	0.000	0	0	0.000	0.000
Palestine	11,225	0.200	11,225	0	0.000	7.821
Panama	2380	0.000	2380	0	0.000	4.923
Papua New Guinea	1019	0.000	1019	0	0.000	2.216
Paraguay	2342	0.000	2342	0	0.000	4.733
Peru	15,002	0.300	15,002	0	0.000	8.386
Philippines	13,560	0.200	11,835	2439	0.129	10.870
Poland	43,767	0.800	31,237	16,278	0.619	17.778
Portugal	20,517	0.400	12,917	10,853	0.217	13.825
Puerto Rico	0	0.000	0	0	0.000	0.000
Qatar	7016	0.100	2768	5272	0.058	8.778
South Korea	179,400	3.100	126,524	58,150	1.505	17.189
Moldova	14,678	0.300	14,037	1519	0.011	9.426
Romania	36,042	0.600	25,422	13,358	0.262	15.291
Russia	162,147	2.800	49,572	127,747	2.897	20.518
Rwanda	2839	0.000	2778	81	0.121	7.947
Saint Kitts Nevis	481	0.000	481	0	0.000	1.351
Saint Lucia	1530	0.000	1390	224	0.138	2.185
Saint Vincent Grenadines	892	0.000	892	0	0.000	1.757
Samoa	654	0.000	654	0	0.000	1.445
San Marino	791	0.000	791	0	0.000	0.618
Sao Tome Principe	2424	0.000	2424	0	0.000	1.377
Saudi Arabia	52,105	0.900	41,503	13,216	0.573	16.510
Senegal	11,917	0.200	11,917	0	0.000	6.400
Serbia	19,935	0.300	10,854	9390	0.107	8.998
Seychelles	367	0.000	367	0	0.000	2.497
Sierra Leone	641	0.000	641	0	0.000	4.326
Singapore	20,009	0.300	20,009	0	0.000	6.610
Slovakia	33,160	0.600	30,883	7839	0.037	12.425

(Continued)

Table 1. (Continued).

Country	Degree	Share (%)	Out-degree	In-degree	Between	Eigen
Slovenia	3848	0.100	2446	1821	0.060	8.613
Solomon Islands	2999	0.100	2999	0	0.000	1.672
Somalia	2082	0.000	2082	0	0.000	4.992
South Africa	38,544	0.700	6145	32,415	0.098	10.545
Spain	70,877	1.200	23,268	55,573	1.222	19.328
Sri Lanka	16,133	0.300	16,133	0	0.000	8.931
Sudan	4271	0.100	4271	0	0.000	9.775
Suriname	750	0.000	750	0	0.000	1.933
Swaziland	3949	0.100	3846	103	0.009	2.863
Sweden	35,013	0.600	14,763	24,831	0.438	19.038
Switzerland	39,948	0.700	11,155	37,205	0.476	20.131
Syria	12,616	0.200	12,616	0	0.000	10.032
Tajikistan	9634	0.200	6540	3362	0.011	6.336
Thailand	41,136	0.700	26,202	17,927	0.344	7.257
Timor Leste	3680	0.100	3680	0	0.000	2.307
Togo	3287	0.100	2837	535	1.089	5.660
Tokelau	0	0.000	0	0	0.000	0.000
Tonga	1460	0.000	1460	0	0.000	1.412
Trinidad Tobago	6067	0.100	5585	945	0.289	4.219
Tunisia	20,321	0.300	19,483	1130	0.013	8.283
Turkey	59,403	1.000	49,077	18,354	1.923	16.759
Turkmenistan	14,493	0.200	14,493	0	0.000	6.007
Turks Caicos	221	0.000	221	0	0.000	1.041
Tuvalu	401	0.000	401	0	0.000	0.736
Uganda	3363	0.100	3363	0	0.000	7.711
Ukraine	56,158	1.000	35,117	25,437	0.067	12.488
UAE	8458	0.100	8458	0	0.000	6.059
UK	387,920	6.700	23,091	387,648	2.938	22.877
Tanzania	5823	0.100	5605	272	2.030	9.368
USA	663,387	11.400	51,776	653,962	7.920	23.053
Uruguay	2187	0.000	2187	0	0.000	4.679
Uzbekistan	23,542	0.400	23,420	287	0.011	9.184
Vanuatu	1694	0.000	1694	0	0.000	1.376
Venezuela	15,027	0.300	13,267	1898	0.098	8.698
Viet Nam	50,385	0.900	47,981	3246	0.446	10.194
Yemen	5928	0.100	5928	0	0.000	7.157
Zambia	4950	0.100	4950	0	0.000	8.260
Zimbabwe	20,465	0.400	19,640	848	0.054	9.916
Mean	27,645	0.500	14,650.338	14,650.338	0.265	7.932
SD	74,998	0.013	43,248.445	60,087.465	0.782	5.699

and some in East Asia (China, Japan, South Korea, Singapore, Indonesia, Macao, Hong Kong, India, Nepal, Vietnam, Thailand and Malaysia) as well as some other countries (Turkey, Saudi Arabia and Nigeria). As in the case

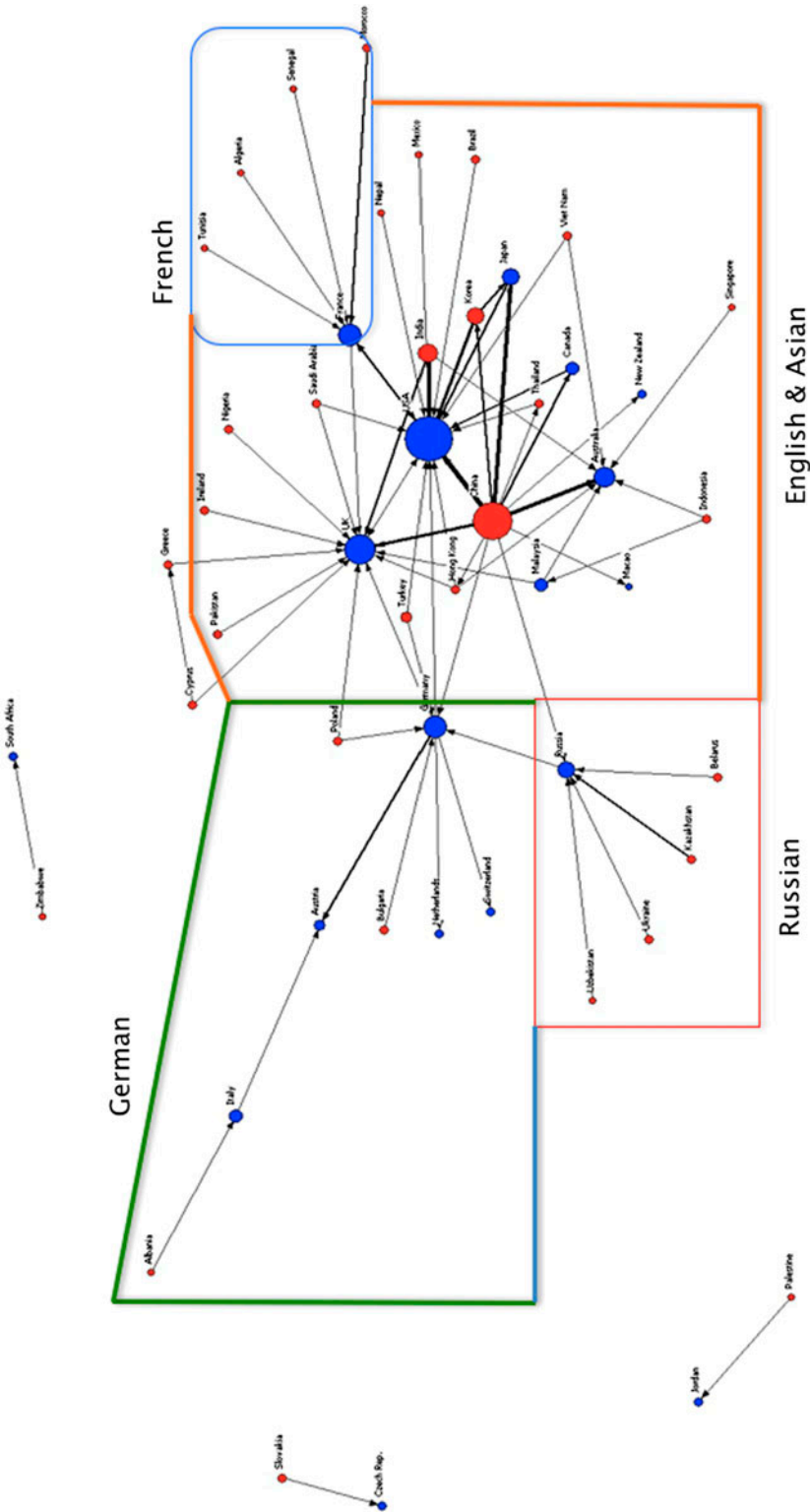


Figure 1. International student flows network.

of the whole network, this group is centred about the USA and the UK. These clusters suggest that language and culture are important factors influencing the network structure, which may also have some implications in terms of colonial and regional linkages.

Figure 1 visualises the flow network of international students. Node size is based on the overall degree centrality of countries, and the darker the line connecting two countries, the larger the number of students that are studying in the country at the end of the arrowhead. A total of 7325 students (half of the mean number of students) are required for a line to be drawn. Red countries send more students abroad than they receive, and blue ones receive more than they send. Figure 1 shows the four major clusters. In addition, there are a number of regional dyads, including Greece and Cyprus, Jordan and Palestine, the Czech Republic and Slovakia, and Zimbabwe and South Africa, suggesting that Greece, Jordan, the Czech Republic and South Africa are countries having certain tractions in the dyadic relationships with their counterpart countries in their respective regions.

Predicting the network structure

A number of different networks are used as predictors of the flow of international students. These networks include the physical distance, common borders, common languages, bilateral hyperlink connections, the number of telephone minutes and the amount of trade between countries.

To predict the structure of the flow network of international students, both QAP correlation and regression analysis methods are employed. To control for extreme values and normalise highly skewed distributions, a log transformation is used for telephone, hyperlink and trade networks. Table 2 shows the means and standard deviations for these networks and Table 3 shows the QAP correlations between the predictors and the flow network of international students. There are weak but significant correlations between flow network, physical distance (the closer two countries, the larger the number of students), common borders, total hyperlinks, the number of telephone minutes and the amount of trade. The student flow is correlated

Table 2. Means and standard deviations for all networks.

	Mean	SD
Student flows	15.42	77.53
Common border	0.02	0.13
Great circle distance	4909.69	2793.33
Languages	0.19	0.39
Log telephone	0.07	0.36
Log hyperlinks	1.48	1.62
Log trade	6.86	1.69

Table 3. Quadratic assessment procedure correlations among networks.

	Student flows	Common border	Distance	Languages	LTele	LHyper	LTrade
Student flows	1.0						
Common border	0.128*	1.0					
Great circle distance	-0.126*	-0.195*	1.0				
Languages	0.025	0.081*	0.015	1.0			
Log telephone	0.239*	0.212*	-0.140*	0.053*	1.0		
Log hyperlinks	0.247*	0.104*	-0.085*	-0.045	0.358*	1.0	
Log trade	0.213*	0.082*	-0.184*	-0.037	0.264*	0.573*	1.0

Notes: * $p < .01$; $n = 188$; LTele = Log telephone, LHyper = Log hyperlinks, LTrade = Log trade.

Table 4. Quadratic assessment procedure multiple regressions.

R-square	Adj R-Sqr	Probability	# of Obs
0.103	0.103	> .001	33,672
Independent	Standardised coefficient	Significance	
Intercept	0.000		
Trade (log)	0.078	0.000	
Common border	0.062	0.000	
Great circle distance	-0.068	0.000	
Languages	0.023	0.009	
Telephone (log)	0.145	0.000	
Hyperlinks (log)	0.139	0.000	

with the physical distance ($r = -.126$; $p < 0.001$), common borders ($r = .128$; $p < 0.001$), telephone minutes ($r = .239$; $p < 0.001$), hyperlinks ($r = .247$; $p < 0.001$) and the amount of trade ($r = .213$; $p < 0.001$). There are no significant correlations between language and student flow ($r = .025$; $p = .061$), the physical distance ($r = .015$; $p = .301$), total hyperlinks ($r = -.045$; $p = .103$) and trade ($r = -.037$; $p = .158$). Language is weakly correlated with telephone minutes ($r = .053$; $p = .012$) and common borders ($r = .081$; $p < 0.001$).

Because many of the antecedents are related, a QAP multiple regression analysis is conducted to determine their independent and combined effects on the flow structure of international students. Table 4 shows the best-performing model. Among all the indicators, telephone minutes (0.145; $p < .001$) and bilateral hyperlink connections (0.139; $p < .001$), the communication variables, are the most significant predictors of the flow structure of international students, followed by the amount of trade (0.078; $p < .001$), the physical distance (-0.068 ; $p < .001$), common borders (0.062; $p < .001$) and common languages (0.023; $p < .01$).

Discussion

The findings indicate some nuanced impacts of language on the flow of international students. Specifically, the network of international student flows is clustered into four groups differentiated by their language and culture. However, the QAP correlation indicates only a weak correlation between the student flow and language. This seems to be mainly because China sends the most number of students abroad and a majority of international students from China are studying in non-Chinese-speaking countries such as the USA, the UK, Australia, Canada, France, Germany, Japan, Korea and Russia.⁸

The heavy flow of international students in European countries also weakens the predictive power of language because Europeans speak many different languages.

At the country level, the USA is by far the most central country in the international student network, followed by China, the UK, France, Germany, Australia and India. The results reveal a center-periphery network structure consistent with World-System Theory. The core countries in the world system, the USA, the UK, Australia, France, Germany and Japan, receive most of the international students, whereas semi-periphery countries such as China, India and South Korea, and periphery countries, Malaysia and Vietnam, send most of the international students to other countries. Although scholars have argued that the pattern of the flow of international students from the periphery toward the core reinforces the inequitable distribution of resources and knowledge as a result of the brain drain (Chen and Barnett 2000; Lee 2008; Weiler 1984), the impact of this pattern should be investigated from a dynamic perspective. For example, Maringe and Carter (2007) reported that the decision-making and motivations of African students who come to study in England are complex and therefore cannot be simply reduced to the perspective of brain drain. In addition, although South Korea and China are gradually moving from the semi-periphery to the core, the flow pattern of international students is likely to be reshaped and have differential effects on the global economy, politics and culture. Indeed, the diversification of overseas destinations of South Korean and Chinese

students and the growing flows of South Korean and Chinese students within East Asia have been observed since 2000 (UNESCO Bangkok 2013).

Findings also show that countries such as Greece, Jordan, the Czech Republic and South Africa have certain levels of tractions in the dyadic relationships with their counterpart countries in their respective regions. In this regard, Kondakci's (2011) view of Greece, Jordan, the Czech Republic and South Africa as regional hubs attracting students within their geographic regions seems to be somewhat overestimated. In the periphery of the world system, these countries are not so much regional hubs as favourable destinations for their respective counterpart countries (i.e., Cyprus, Palestine, Slovakia and Zimbabwe).

Based on all these findings, we suggest that future research should pay more attention to the emerging stratifications and regional clusters of the mobility network of international students and investigate the relationship between the flow of international students and the regional economy, politics, culture and institutional features of higher education systems.

In this article, we predict the flow network of international students from physical distance, common borders, total hyperlink connections, the number of telephone minutes and the amount of trade between countries. Somewhat unexpectedly, sharing the same language is not a strong predictor, even though for some periphery countries, such as Mexico, sharing the same language is an important factor of international student mobility. However, this finding is understandable, given the fact that Chinese students are the majority of international students and still the vast majority of them choose English-speaking countries for study abroad. In line with the importance of language, the effect of the communication variables (i.e., telephone minutes and bilateral hyperlinks) on shaping the structure of international student flows could be understood. Notably, the number of telephone minutes shows the most significant association with the structure of international student flows (see Table 4). This finding suggests that family linkages might play a role in international student flows; for example, for international students, their (and their families') easy access to telephone communication with host universities in their home countries might be important. However, given the nature of our study as quantitative analysis, we call for scholars to further investigate why and how such communication aspects shape critically the flow of international students through more qualitative-oriented studies. In addition, although the percentage of the variance explained in the predictive model is low ($R^2 = .103$), indicating that communication explains a small portion of the total variance in the flow of international students, we think that quantitative researchers would benefit from taking communication into account in the investigation of the flow of international students.

Despite the limited feature of data in our study, we think that the importance of the communication variables in shaping the pattern of international student flows may be resonated with the fundamental characteristic of our

era as an information and network society (cf. Castells 2000). This argument could be further advanced by bilateral hyperlinks, the second most significant predictor of international student flows. In order to understand the relation between bilateral hyperlinks and international student flows in the information society (Webster 2007), it is imperative to investigate the effects of the Internet. The Web Index is the first multidimensional measure relating the World Wide Web to global development and human rights (About the Web Index [n.d.](#), para. 1). The indicators of the Web Index include the four areas of universal access, freedom and openness, relevant content and empowerment. Universal access measures whether countries have invested in affordable access to a high-quality Internet infrastructure, as well as investment in education and skills that citizens need to use the Web. Freedom and openness assesses the extent to which citizens enjoy rights to information, opinion, expression, safety and privacy online. Relevant content emphasises the extent to which different stakeholders can access relevant information in the language that they are most comfortable with and via platforms and channels that are widely available. Empowerment measures the difference that the web is making to people, and the extent to which the use of the web by stakeholders is fostering positive impacts on four key areas: society, economy, politics and the environment. The various Web Indexes correlate highly with a number of the international student flow network's centrality scores (Table 5). The overall degree centrality is correlated with the rank of Web Index score ($r = -.31$; $p < 0.01$), Web Index score ($r = .32$; $p < 0.01$), universal access ($r = .31$; $p < 0.01$), relevant content ($r = .33$; $p < 0.01$), impact and empowerment ($r = .45$; $p < .001$). Eigenvector centrality correlates with the rank of Web Index score ($r = -.60$; $p < 0.001$), Web Index score ($r = .61$; $p < 0.001$), universal access ($r = .60$; $p < 0.001$), freedom and openness ($r = .39$; $p < .001$), relevant content ($r = .55$; $p < 0.001$), impact and empowerment ($r = .69$; $p < .001$). In-degree centrality correlates with the rank of Web Index score ($r = -.43$; $p < 0.001$), Web Index score ($r = .44$; $p < 0.001$), universal access ($r = .39$; $p < 0.001$), relevant content ($r = .41$; $p < 0.001$), impact and empowerment ($r = .56$; $p < .001$). Betweenness degree centrality correlates with the rank of Web Index score ($r = -.34$; $p < 0.01$), Web Index score ($r = .35$; $p < 0.01$), universal access ($r = .30$; $p < 0.01$), relevant content ($r = .31$; $p < 0.01$), impact and empowerment ($r = .49$; $p < .001$).⁹ In addition, the overall degree centrality, eigenvector centrality and in-degree centrality all highly correlate with the impact of the use of the web on the development of society, economy and politics, the affordability of building high-quality Internet infrastructure and the creation of web content that can satisfy users' needs. Working together, these web indicators create different ecological environments that facilitate and block communicative activities on a global scale, and thus contribute to the formation of the flow of international students. In particular, these Web Indexes play a more important role in

Table 5. Correlations of the Web Index with the centrality scores of international student flows.

		SF	SF	SF	SF	SF	SF
		Degree	In-degree	Out-degree	Between	Eigen	Share
Rank	<i>r</i>	−0.310	−0.432	0.024	−0.344	−0.592	−0.310
	Sig.	0.005	0.000	0.831	0.002	0.000	0.005
Web Index	<i>r</i>	0.317	0.439	−0.022	0.354	0.609	0.317
	Sig.	0.004	0.000	0.844	0.001	0.000	0.004
Access	<i>r</i>	0.313	0.389	0.038	0.300	0.595	0.313
	Sig.	0.004	0.000	0.736	0.006	0.000	0.004
Education	<i>r</i>	0.251	0.367	−0.040	0.266	0.507	0.251
	Sig.	0.024	0.001	0.723	0.016	0.000	0.024
Affordability	<i>r</i>	0.358	0.410	0.085	0.331	0.597	0.358
	Sig.	0.001	0.000	0.450	0.003	0.000	0.001
Infrastructure	<i>r</i>	0.258	0.302	0.056	0.235	0.553	0.256
	Sig.	0.020	0.006	0.619	0.035	0.000	0.021
Relevant content	<i>r</i>	0.327	0.411	0.031	0.313	0.552	0.327
	Sig.	0.003	0.000	0.787	0.004	0.000	0.003
Web use	<i>r</i>	0.235	0.309	0.004	0.191	0.449	0.234
	Sig.	0.035	0.005	0.972	0.087	0.000	0.036
Content creation	<i>r</i>	0.399	0.487	0.054	0.423	0.619	0.399
	Sig.	0.000	0.000	0.632	0.000	0.000	0.000
Free and open	<i>r</i>	0.062	0.239	−0.196	0.188	0.389	0.063
	Sig.	0.584	0.032	0.079	0.094	0.000	0.579
Free of web	<i>r</i>	0.062	0.239	−0.196	0.188	0.389	0.063
	Sig.	0.584	0.032	0.079	0.094	0.000	0.579
Impact	<i>r</i>	0.447	0.556	0.044	0.485	0.687	0.447
	Sig.	0.000	0.000	0.696	0.000	0.000	0.000
Political impact	<i>r</i>	0.320	0.446	−0.026	0.373	0.635	0.320
	Sig.	0.004	0.000	0.817	0.001	0.000	0.004
Social impact	<i>r</i>	0.458	0.548	0.070	0.504	0.629	0.459
	Sig.	0.000	0.000	0.537	0.000	0.000	0.000
Economic impact	<i>r</i>	0.490	0.578	0.090	0.497	0.676	0.489
	Sig.	0.000	0.000	0.424	0.000	0.000	0.000

Note: SF = student flow.

attracting students to pursue higher education abroad. For example, Barnett et al. (2014) found that the USA and the UK have the highest in-degree centrality in the network of international students and at the same time they have very high Web Index scores. Similarly, Lee and Park (2012) reported that universities in the USA and the UK dominated central positions in various network structures of web visibility, which appears to enhance US and UK universities' international visibility and reputation among key stakeholders, such as prospective students.¹⁰ However, it should be pointed out that there are no significant correlations between out-degree centrality and any of the Web Indexes. Thus, scholars should also examine the relations

between web development at the global level and unequal distribution of academic human resources (Barnett et al. 2014).

Future research also should examine the changes in the network of flows of international students over time and include additional predictor variables to examine this network as a multilevel system. At the macro level, the country of origin has been shown to be a predictor of the flow of international students (Altbach 1991; Chadee and Naidoo 2009; Finn 1997; Kim, Bankart, and Isdell 2011). In addition, individual countries' economic growth and their higher-education policies should be taken into account. Further, instead of focusing only on country effects, more attention should be paid to activities of various institutions and agents. At the meso level, the rankings and quality of higher-education institutions and the cost factors related to higher education study (e.g., accommodation and living costs) have been reported as important predictors of the flow structure of international students (Bein, Noel, and Ragot 2012). Also, we note that based on neo-institutional theory or actor network theory, some scholars pay special attention to how international organisations (e.g., the World Bank, UNESCO, the OECD and the EU) have shaped global education governance (e.g., Chabbott 2003; Lee, Thayer, and Madyun 2008; Resnik 2006). Despite this, since our analytical model did not include the possible role of key international organisations in the flow of international students, future studies need to chart this terrain. In addition, factors such as the cultural, political and historical proximity between home and host countries may be important predictors of the flow of international students (Chan and Ng 2008; Kondakci 2011). Furthermore, the academic network can be considered an autopoietic and self-organising system requiring the sharing of information among scholars and students (Barnett et al. 2014; Manturana and Varela 1980). In this regard, it should be meaningful to examine the relationship between self-organised academic networks and the flow network of international students.

In sum, this paper presents a network analysis of the flow of international students among 210 countries and describes the network and the factors influencing its structure at the country level. Among the predictor variables, total Internet hyperlink connections and the number of telephone minutes are the most important predictors of the structure of international student flows. These results are discussed in light of world-system theory. Finally, future research should examine how the flow network of international students changes over time and consider additional predictor variables to investigate this network as a multilevel system.

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Notes

1. Similar barriers related to visa and immigration are found in the UK and Australia.
2. In the theory, 'world-system' refers to transnational or regional division of labour or role, which partitions the world into core countries, semi-periphery countries and periphery countries (Wallerstein 1974). As such, World-System Theory emphasises the core/periphery pattern as a reflection of a hegemonic relationship. Put differently, World-System Theory is the macro-level approach to world stratification systems.
3. As Teferra (2005) pointed out, 'brain drain' may be an outmoded concept in capturing the emerging phenomenon of the global mobility of highly skilled immigrants, given the complexity shaping the global mobility of highly skilled experts such as intellectual diaspora. In this context, he suggests the need for scrutinising the concept of brain drain from the perspective of brain circulation.
4. This suggests that international students are not a monolithic entity in terms of their motivations, mobility patterns and demographic profiles. Brooks and Walters (2011) illuminated not just the commonalities but also differences of mobile students from East Asia, Europe and the UK in terms of their motivations, objectives and experiences. Some further numeric information about the heterogeneities can be found in statistics from UNESCO (UNESCO Institute for Statistics 2012).
5. For the conceptual discussion of educational hubs, see Knight (2011).
6. The QAP correlation algorithm proceeds in two steps (Borgatti, Everett, and Freeman 2002). First, it computes the Pearson correlation between corresponding cells of two networks. Second, it randomly permutes rows and columns (synchronously) of one matrix and re-computes the correlation hundreds of times to determine the number of times that a random measure is greater than or equal to the measure calculated in the first step. A low proportion (< 0.05) suggests a strong relationship between networks that is unlikely to have occurred by chance.
7. Similar to the QAP correlation procedure, the QAP regression algorithm has two steps. First, it performs a standard multiple regression analysis across corresponding cells of dependent and independent matrices. Second, similar to the QAP correlation, it randomly permutes rows and columns of the dependent matrix and re-computes the regression, repeating this step hundreds of times to estimate standard errors for the statistics of interest. For each coefficient, the program determines the proportion of random permutations that yield a coefficient as extreme as the one computed in the first step.
8. The finding also suggests that China still appears to face the issue of brain drain. At the same time, however, recent studies of Chinese students who

returned home from their study abroad suggest that China is starting to benefit from brain circulation, given that most of the returnees not only bring new cognitive skills but also engage in new processes of professionalisation and socialisation in their home society (e.g., Gu 2012).

9. It should be recalled that the USA is by far the most central country in terms of betweenness centrality in international student flows. Along with this finding, the high correlations between betweenness centrality and various Web Indexes suggest that the USA plays a role as an information broker in the network of international student flows, which is supported by the strong and positive features of the Web based in the USA.
10. Drawing from the highly positive correlations between various measures of web-visibility and university rankings, Lee and Park (2012) also concluded that certain features of web visibility can function as a proxy measure of university reputation.

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